

CHAPTER 1 INTRODUCTION

When better roads are built, the Arizona highway department will build them (Arizona Highways, December 1939:49).

The Arizona State Highway Department, now known as the Arizona Department of Transportation (ADOT), has been building roads across Arizona since territorial days. Counties, municipalities, and private developers also have constructed roads throughout the state. Today, Arizona is crossed by more than 6,000 miles of highways and most communities where Arizonans have made their homes or earned their livelihood for over 100 years are accessible by highways.

ADOT'S HISTORIC PRESERVATION CHALLENGES

The importance of roads to the functioning of American society can hardly be overemphasized. The primary mission of ADOT is to build and maintain an adequate and safe highway system that is a vital element of our modern lives in Arizona. A secondary, but important ADOT mission is to preserve important historic properties associated with the history of road building throughout the state. State and federal historic preservation laws stipulate that ADOT identify, evaluate, and appropriately manage significant historic roads, as well as other types of historic properties on lands managed or affected by ADOT projects and programs.

The ubiquity of roads and their long, linear nature make them difficult candidates for historic preservation. Roadways pose a challenge for historic preservation planning for the following reasons:

- Evaluating the significance and integrity of historic roads often can be challenging.
- Preserving historic roads can conflict with the need for modern, safe highways.
- Preserving historic roads often requires the cooperation of multiple jurisdictions and landowners.
- Defining boundaries and documenting characteristics of historic roads can be difficult within the confines of cultural resource management surveys that often encompass only limited segments of such roads.
- Evaluating the effects of proposed undertakings on historic roads may be difficult due to differing opinions of cumulative impacts.

ADOT has had to address all of these issues on numerous occasions. Indeed, they arise in connection with almost every proposal to improve existing roads. As an example, in the early 1990s ADOT struggled to cope with the discovery of remnants of the Reno Wagon Road late in the planning of upgrades to State Route 87. Was the old wagon road important and therefore eligible for the National Register of Historic Places (National Register)? If so, under what criteria was it eligible? Would the obliteration of short segments of the wagon road within the highway right-of-way be an adverse effect as defined by regulations implementing the National Historic Preservation Act, or an unacceptable "use" as defined by Section 4(f) of the National Transportation Act? Could the impacts be satisfactorily mitigated or were there prudent and feasible alternatives (such as costly redesign) that would have to be implemented to avoid impacts? In response to these experiences, ADOT decided to commission the development of this

historical study of road building in Arizona to provide background information for more consistent and less ad hoc evaluations of the significance and integrity of historic roads.

Actually, the original goals of this study were more ambitious, and—from the vantage of hindsight—more unrealistic. ADOT hoped to identify and achieve consensus with all involved regulatory and land-managing agencies about every National Register-eligible road in the state. The modified goal of writing a historic context that would establish perspectives, policies, and procedures for consistently evaluating historic roads throughout the state also was not fully achieved. There is some consolation in recognizing that it is not a simple task to develop a general consensus among the many parties interested in historic roads, and to date, no other state has had any significant degree of success. Lindauer (1998, 2001) discusses ADOT's perspective on this evolving study.

This overview is confined to a consideration of *built roads* and does not address trails or more generalized transportation routes. The word *trail* is used in this document to refer to pathways developed through use, be it foot traffic, the use of horses, mules, or oxen, or overland travel in wagons or motorized vehicles. Such trails were addressed in the previously prepared Arizona State Historic Preservation Office (SHPO) historic context study, *Historic Trails in Arizona from Coronado to 1940* (Stein 1994). The distinguishing characteristic of a *road*, as the term is used here, is that it was intentionally constructed for use by wheeled vehicles, including wagons, coaches, and carriages drawn by dray animals as well as mechanically-powered vehicles. Thus, a two-track “road” created and maintained entirely by being driven over is considered to be a trail. Only if it has been graded or otherwise improved in some fashion, is a route considered to be a road. Admittedly, the distinction between a road and a trail can be ambiguous and definitions may need to be adjusted to specific situations. Some improvements, such as cuts and fills or bridges, may have been built along trails in areas of difficult terrain, but the corridors remain essentially trails because they required no road construction where the going is easier. Conversely, some early roads involved little construction across flat, level terrain and these segments are essentially trails developed through use. Many roads were constructed along existing trails or were built to follow established transportation corridors or routes. Therefore it is not unusual to encounter mixed remnants of older trails or roads within the corridors of our modern roads.

Nomenclature, too, can be confusing. For example, the Camino del Diablo, commonly translated as “Devil’s Road,” originally was not a constructed road, but instead a set of trails between Caborca, Mexico, and Yuma, Arizona, developed through use over time.¹ During pre-Columbian times, some aboriginal societies *built* trails for foot traffic, such as the “roads” leading to Chaco Canyon in northwestern New Mexico, as well as trails and bridges the Incas built in South America (Trombold 1991). No such aboriginal “roads” have been documented in Arizona and they are not addressed in this overview.

As this study evolved, its focus narrowed from all roads to the history of highways designated by the territorial, state, and federal governments. Highway designation encompassed only a small percentage of all roads, but such designation reflected the government’s perception of which roads were most important within a broad transportation network. In the early days of road development, designation of a road as a highway did not necessarily imply any particular standard about the quality of a road. Some stretches of the early territorial and state highways may, in fact, have been little more than marked trails until funds became available to grade the roadbeds and drainage ditches, and construct cross-drainage structures.

¹ A portion of the Camino del Diablo, defined as a 0.5-mile-wide corridor approximately 80 miles in length, was listed in the National Register in 1970. Today, there is a graded road within this transportation corridor, but whether the road is precisely coincident with the original trail or trails is undetermined.

Although some city streets were incorporated into these highway networks, urban streets have distinct developmental histories tied to individual communities, and they are not addressed in this overview.

Although the modern highways of Arizona may seem to be a coherent system resulting from thoroughly thought-out plans, they actually represent an amalgamated network of individual roads developed and modified for a variety of reasons over the years. This overview does not attempt to document the historic details of individual roads, but presents an overall perspective of how the principal roads of Arizona were developed and incorporated into a highway network. One observer has argued that once we learn to “read” the physical attributes of roads and the landscapes they cross, historic roads become great outdoor museums (Schlereth 1997). Certainly not every road in Arizona is historically significant or a museum to be preserved, but this overview is offered to promote broader appreciation of the historical development of Arizona highways and to promote consistency in fulfilling ADOT’s cultural resource management regulatory responsibilities.

REGULATORY CONSIDERATIONS

Regulatory requirements that require ADOT to consider the historical values of roads (and other historic properties) stem principally from three pieces of federal legislation: (1) the National Historic Preservation Act of 1966 (NHPA), (2) Department of Transportation Act of 1966, and (3) National Environmental Policy Act of 1969 (NEPA). ADOT projects that involve funding or approval by the Federal Highway Administration (FHWA), or require right-of-way across federal land, are federal undertakings, and ADOT must work with FHWA, and any involved federal land-managing agencies, to comply with NEPA, Section 106 of NHPA, and Section 4(f) of the Department of Transportation (DOT) Act. An important scheduling consideration stems from FHWA policy that requires compliance with Section 4(f) and Section 106 be demonstrated prior to issuance of a decision notice under NEPA.

Section 106, National Historic Preservation Act

NHPA defines *historic properties* to include prehistoric and historic sites, buildings, structures, districts, and objects included in, or eligible for inclusion in, the National Register, as well as artifacts, records, and remains related to such properties (NHPA 301[5]). Section 106 of NHPA requires federal agencies to take into account the effects of their activities and programs on National Register-listed or eligible properties. ADOT receives funding from FHWA for many projects and this federal funding or any required federal approvals, permits, or rights-of-way entail compliance with Section 106. FHWA and other involved federal agencies expect ADOT to conduct studies and compile documentation to assist them in complying with Section 106.

Regulations for *Protection of Historic Properties* (Title 36, Code of Federal Regulations [CFR], Part 800) define the key regulatory requirements. These regulations define a process for federal agencies to consult with SHPOs, the federal Advisory Council on Historic Preservation (ACHP), and other interested parties to ensure that historic properties are duly considered as federal projects are planned and implemented. The steps in the Section 106 consultation process involve the following:

- identifying the area of potential effect of a proposed undertaking, developing an appropriate inventory strategy, and identifying potential interested parties in consultation with the SHPO
- identifying cultural properties that may be affected by a proposed undertaking and evaluating the eligibility of those properties for the National Register

- assessing the potential effects of the undertaking on properties determined to be eligible for the National Register
- consulting with the SHPO, ACHP, and other interested parties (such as local government officials, American Indian tribes, and project proponents) to determine ways to avoid or reduce any identified adverse effects
- if necessary, providing the ACHP a reasonable opportunity to comment on the proposed undertaking and effects on properties eligible for the National Register
- proceeding with the undertaking under the terms of a memorandum of agreement or programmatic agreement, or in consideration of ACHP comments, if required

To be determined eligible for inclusion in the National Register, properties must be important in American history, architecture, archaeology, engineering, or culture. They also must possess integrity of location, design, setting, materials, workmanship, feeling, and association, and meet at least one of the following four criteria:

Criterion A: are associated with events that have made a significant contribution to the broad patterns of our history

Criterion B: are associated with the lives of persons significant in our past

Criterion C: embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant distinguishable entity whose components may lack individual distinction

Criterion D: have yielded, or may be likely to yield, information important in prehistory or history

To be eligible for National Register listing, a property must be at least 50 years old, unless it has exceptional significance, and meets one or more of the eligibility criteria, and also retains sufficient integrity to convey its historic significance. Therefore, the aspects of location, design, setting, materials, workmanship, feeling, and association that are considered essential to the historical identity of the property must be clearly specified. Not all aspects of integrity are equally important for every historic property, and determining which are important for a given property must be based on understanding why, where, and when the property was significant (National Park Service 1998:44-45). A sound determination of effect under Section 106 of NHPA must evaluate whether a proposed undertaking will diminish significant aspects of a property's integrity. For example, consider a historic road determined eligible for National Register listing because of the historic integrity of its important associations, location, setting, and feeling, but which does not retain original materials or aspects of workmanship. A proposed undertaking that would alter the fabric of the road (such as a road resurfacing project or installation of a buried utility line that cuts through the road surface) but not change the road's setting and feeling, would result in no adverse effect. Alternatively, construction of a nearby power line that visually intrudes into on an otherwise unaltered setting might result in an adverse effect on such a road.

A related issue of particular relevance to the evaluation of linear structures such as roads is the fact that simply by virtue of their length, many roads are composed of segments of varying integrity. They may have pristine stretches that exemplify their historic significance, but in other areas the road may have been upgraded and surrounded by modern developments. Thus, when evaluating the eligibility of a historic road and assessing potential project effects, it is important to identify and distinguish between those

segments that retain sufficient integrity to be regarded as historic character defining elements and those that do not. Such analyses have to consider specific factors related to individual roads.

Section 4(f), Department of Transportation Act

Section 4(f) of the DOT Act of 1966, recodified in 1983 as 49 United States Code, Section 303(c), established a federal government policy of making special efforts to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites. Section 4(f) stipulates that DOT may approve a program or project that uses land from any significant historic site only if two conditions are met. First, there must be no prudent and feasible alternative to the use of the land from the property. Second, the action must include all possible planning to minimize harm to the property resulting from such use.

DOT defines significant historic sites to include all prehistoric or historic sites, buildings, structures, objects, or districts that have been determined eligible for listing in the National Register unless the properties are valued only for their potential information, which can be recovered and does not require preservation in place. Properties eligible for the National Register only under Criterion D for their information potential are not considered Section 4(f) resources. If historic properties determined eligible for National Register listing under Criteria A, B, or C are subject to effect from a proposed DOT undertaking, considerable additional planning efforts may be required to prepare a Section 4(f) evaluation with attendant scheduling and cost implications (like those for the State Route 87 upgrades crossing the old Reno Wagon Road). At its discretion, DOT may apply Section 4(f) considerations to properties designated as historic by local officials having jurisdiction of those sites.

National Environmental Policy Act

NEPA (Section 101[b][4]) establishes a federal policy of encouraging preservation of not only the natural aspects, but also the historic and cultural aspects of our national heritage when federal undertakings are planned. Implementing regulations (40 CFR Part 1502.16[g]) issued by the Council on Environmental Quality stipulate that the consequences of federal undertakings on historic and cultural resources be considered. Ordinarily, a series of alternative means of accomplishing the proposed action are defined and studies are conducted to identify a preferred alternative. While the intent of the legislation is the preservation of our heritage, it does not mandate that all significant impacts be avoided. Instead, it requires that impacts be recognized, and if possible, minimized or mitigated.

State Laws

The Arizona State Historic Preservation Act (Arizona Revised Statutes 41-862 to 41-864) directs state agencies, such as ADOT, to develop programs to inventory and nominate historic properties to the Arizona Register of Historic Places. The criteria for listing on the Arizona Register are identical to those for the National Register. The chief administrators of state agencies are designated as responsible for working to preserve historic properties under their control in accordance with standards recommended by the SHPO. More than any federal law, the State Historic Preservation Act directs ADOT to establish a proactive preservation program rather than just reviews in reaction to proposed projects, although the act also directs state agencies to seek SHPO review of any agency plans that may affect State Register-listed or eligible properties.

The Arizona Antiquities Act stipulates that excavation or removal of artifacts from archaeological sites on state land is illegal without a permit from the Director of the Arizona State Museum. Therefore, it is important for ADOT to ensure that any cultural resource studies undertaken on state lands are conducted under the terms of a duly authorized permit from the Arizona State Museum, and in accordance with standards and guidelines issued by the Museum. The Antiquities Act also directs anyone in charge of construction or other activities on lands owned or controlled by the State of Arizona to report discoveries of archaeological and historical resources to the Director of the Arizona State Museum. Amendments of the Antiquities Act enacted in 1990 specifically address treatment of human remains, associated funerary objects, sacred objects, and items of cultural patrimony found on state or private lands.

ORGANIZATION OF THE HISTORIC OVERVIEW

The purpose of this historic overview of road building is to provide background information for identifying roads in Arizona worthy of preservation. Not all old properties are important. Those that are not should be distinguished from those that are so that management efforts can be appropriately focused. Nor is it necessarily prudent public policy to preserve every historic property. This is especially true when in-use facilities such as roads are being considered. Priorities must be set to ensure that preservation efforts are balanced with other public benefits and do not place unreasonable restrictions on developments designed to improve highway safety and efficiency.

Chapter 2 briefly summarizes the political history and funding of road development in the United States from the founding of the nation through the mid-twentieth century. Chapter 3 summarizes the evolution of the technology of building roads in the United States. The history of road building in Arizona is discussed in Chapter 4, within a framework focusing on each of the four criteria for listing in the National Register.

Development of this document included limited field reconnaissance to explore some of the issues in evaluating the historic significance of roads. Chapter 5 presents five case studies based on field review of selected road segments across the state.

Chapter 6 explores the question of which historic roads in Arizona are worthy of preservation. This chapter identifies some of the challenges of evaluating the National Register eligibility of Arizona's roads, and then discusses application of the four National Register criteria of significance and issues related to assessing historical integrity.

Conclusions and recommendations are presented in Chapter 7. The general perspective of this study might be characterized as "bottom up" because it sought to develop a strategy for dealing with individual roads or even just road segments. Over the long time it took to complete the study, ADOT and the SHPO turned to a more "top down" approach of addressing the entire state highway system as a whole. That still developing change in strategy also is briefly discussed in the concluding chapter.

Appendix A includes a series of maps of the state highway system in 1914, 1924, 1935, 1941, and 1946. Three maps of the state highway system dating from 1912, circa 1925, and 1939 are included as pocket maps. Appendix B is an annotated bibliography of 17 key references related to the history of roads, and Appendix C lists the more than 70 roads currently included in the National Register. Only one of these listings includes properties in Arizona. It is a multiple property documentation form that provides a context for listing properties related to Route 66, including rural segments, urban segments, abandoned segments, and traveler-related facilities.

CHAPTER 2

POLITICS AND FUNDING OF AMERICAN ROAD BUILDING, 1776-1956

The miracle was not the automobile. The miracle of the early twentieth century was the construction of a vast network of highways that gave automobiles someplace to go (Scott and Kelly 1988:3).

Roads are ubiquitous in our lives at the beginning of the twenty-first century, but roads have not always been here. A hundred years ago, the American landscape lacked today's familiar crisscrossing of all-weather roads, highways, and interstates. This chapter reviews the politics and funding of American road building from 1776 to 1956.

The original Pennsylvania Turnpike, a 62-mile-long dirt toll road from Philadelphia to Lancaster built in 1794, was one of the first major roads constructed in the United States. Sixty years later, the Pennsylvania Railroad purchased the abandoned road between Philadelphia and Lancaster and replaced the old turnpike with a railroad (FHWA 1977:13-15; Jordan and others 1987:276-277). The second Pennsylvania Turnpike opened in 1940 as the initial segment of what was to become the interstate highway system. The four-lane divided highway ran 160 miles from Harrisburg to Pittsburgh, using abandoned railroad tunnels in the same way that railroads had cannibalized roads a century before (Patton 1986:77-78).

As illustrated by this Pennsylvania example, American transportation routes have moved from turnpikes to railroads to highways over the last 200 years. The late eighteenth- and early nineteenth-century system of interconnecting roads and waterways gave way to railroads by the 1850s. In the twentieth century, the horsepower of the automobile and a new system of interconnecting roads superseded the "iron horse." To understand the sequence of road building in Arizona, it is important to understand the history of road building in the United States from the early days of wagon roads through the railroad years and into the automobile era.

TURNPIKES, RAILROADS, AND MILITARY ROADS

During colonial times in America, most commercial transporters followed water routes to move goods. Rivers and coastal waterways provided easier passage than the primitive roads that were little more than paths unsuitable for wagon travel. After the American Revolution, President Thomas Jefferson approved legislation in 1806 to build the Cumberland Road from the head of the Potomac River west to the Ohio River. Known as the "best road in the country," the Cumberland Road supported heavy traffic of stagecoaches, freight wagons, and livestock (FHWA 1977:21).

The building of the Cumberland Road sparked a bitter Congressional debate. The losing side of the debate felt that the federal government had no authority to build roads while the other side held that the general welfare clause of the Constitution granted such authority. Years later when Congress attempted to finance the maintenance of the Cumberland Road by authorizing the collection of tolls, the measure was defeated by Madison's veto, which established the federal position on highway financing that remains in effect today. Simply stated, the federal government has the power to make appropriations for public improvements, but it does not have the power to assume sovereignty over the land.

"One of the most striking features of the American road system is that the federal government did not officially build it. Its money, delivered with numerous strings attached concerning location, standards, procedure, and policy, paid for the roads; but the states, counties, and cities built and own them" (Patton 1986:35-36).

The federal government built only a small number of roads in the nineteenth century. Both the federal government and the states issued charters to private turnpike companies to build roads (a practice also followed in territorial Arizona). The privately built roads connected with a system of more than 3,000 miles of publicly financed canals (Jordan and others 1987:200-201).

The success of the turnpike-canal system was cut short by the emergence of the railroad system, which provided a faster and cheaper mode of transporting goods and people. Although the mileage of railroad tracks matched the mileage of canals in 1840 (about 3,000 miles each), the industry built more than 30,000 miles of rail in the 1850s.¹ As traffic decreased on the turnpikes and canals, so did revenue, and turnpike owners could no longer afford to maintain the roadways. Some sold their roads to counties, and some simply abandoned them (FHWA 1977:36; Jordan and others 1987:203). Toll roads were used longer in the West and Arizona, where some were operated into the early twentieth century.

In addition to the abandoned turnpikes, local usage and programs established other trails or roads in rural areas, especially in the eastern states. In the Great Plains and in the West (including parts of Arizona), local roads often followed the section lines of the grid institutionalized in the Land Ordinance of 1785 and the Land Act of 1796 (Patton 1986:31-32). Throughout the nineteenth century, local property and poll taxes paid for most rural road construction and maintenance, with much of the labor provided by a system of compulsory road service that had been in place since the eighteenth century. Because all rural roads, both abandoned turnpikes and common-usage roads, were at best only ditched and graded, not hard surfaced, the years between 1850 and 1900 have been dubbed the “dark age of the rural road”² (FHWA 1977:3-7, 36-39; Jordan and others 1987:200-201). The darkness stemmed largely from lack of funding. During this era, government funding went toward building railroads throughout the nation rather than a network of highways (Goddard 1994).

In the nineteenth century, the federal government also sponsored the construction of military “roads,” primarily in less settled parts of the new country. Military travelers, tradesmen, and settlers all traveled on these roads built by soldiers and hired labor. Between the construction of the Natchez Trace, the first federal military road in 1803, and 1880, the Army built more than 100 military wagon roads totaling over 21,000 miles. During the 1850s and 1860s, the Army marked and improved most of the wagon trails used by pioneers as well as military supply trains. Famous Southwestern examples include the Santa Fe Trail between Kansas City and Santa Fe, Cooke’s Wagon Road from Santa Fe to San Diego built across southern Arizona in 1846, and the 1857 Beale Wagon Road from Fort Smith, Arkansas west across northern Arizona to the Colorado River. During the nineteenth century, these military roads represented essentially the only federal subsidies for road development (FHWA 1977:24-26). Given the rapidity with which these roads were “built,” there could have been little more than identifying and marking with any construction efforts focused on facilitating passage through areas of difficult terrain. Along level sections, some vegetation or rocks may have been removed but they essentially remained trails. Some parts of these “roads” probably were even intended only for pack animals rather than wagons.

¹After the Civil War, railroad companies extended the system of rails throughout the East, as well as into the topographically rugged and arid West where canals were impractical. In the single year 1887, nearly 13,000 miles of track were laid, and by 1900, approximately 260,000 miles of track crisscrossed the United States (FHWA 1977:34).

²The road picture in the cities differed markedly from the rural situation. Concentrations of population, business, and industry in cities provided the tax revenue to fund construction and maintenance of city streets as well as other municipal services such as sewer and water systems, schools, parks, and street lighting. Statistics from 1907 indicate that nearly half of the 47,000 miles of urban streets in cities with populations over 30,000 had been improved with pavement, macadam, asphalt, or gravel (FHWA 1977:41).

FROM BICYCLES TO FEDERAL AID

In 1893, workers in Ohio laid the first brick-surfaced rural road in the United States. That same year, Harvard University began laboratory testing of road materials, good roads boosters gathered in Washington, D.C. to found the National League for Good Roads, the Post Office Department began rural mail delivery, and Congress established the Office of Road Inquiry. Most significantly, J. Frank Duryea's gasoline buggy debuted on the streets of Springfield, Massachusetts (FHWA 1977:191, 265).

In the almost 30 years between 1893 and the passage of the Federal Highway Act of 1921, several forces combined to bring the issue of good roads into the national spotlight. Bicycle riders and advocates for rural mail delivery first supported road construction, but it was the explosion of automobile owners in the twentieth century and the myriad of good roads associations that precipitated federal action on a large scale. The president of the National Highways Association stated that "to have Good Roads everywhere throughout the United States will mean more to this nation than any other development since the Declaration of Independence" (State Engineer 1914:144).

Local county governments were the first entities to assume the work and expense of building and maintaining local roads across the rural landscape. The necessity of coordinating roads across county lines led to the consolidation of county road work under state highway departments. Later, the necessity of connecting routes across state lines contributed to bringing the federal government into the road-building business. When the conversations started in the 1890s, "good roads" meant graded dirt roads for wagons and bicycles, and by the time Congress passed the Federal Highway Act of 1921, the term had come to mean paved, all-weather roads for motorized vehicles.

BICYCLES AND MAIL

Bicyclists, not motorists, first worked to improve the road system. With the invention of the safety bicycle³ and the pneumatic tire in the 1880s, a bicycle craze spread across the country in the 1890s, including Arizona (Pry 1990). Although most bicycling was confined to urban areas, some sporting types left the paved city streets and ventured into the country. These cyclists experienced the poor condition of rural roads, and began complaining. Because many of these cross-country cyclists were relatively wealthy and politically connected, their voices carried weight. First organized in 1880 as a group of bicycle clubs, the League of American Wheelmen transformed itself into a powerful political lobby for good roads. In 1892, the League began publishing the magazine *Good Roads*. The editor, a civil engineer, educated his readers on the civil engineering of good roads, highlighted existing good roads, and contrasted the poor state of American roads with the well-engineered roads in France. Such publicity helped to turn public opinion in favor of the taxes required to fund road construction (FHWA 1977:42-43).

Other organizations appeared in the 1890s and supported the League of American Wheelmen's push for road improvements. The first Good Roads Association was formed in Missouri in 1891. The National League for Good Roads, founded in 1893, held the first national road conference in 1894. The League urged states to create highway commissions, set up systems of state roads, and enact legislation to build good roads. It is important to remember that these 1890s organizations worked to improve rural roads to better support bicycle and wagon traffic and not motorized vehicles, which were only a curiosity before the turn of the century (FHWA 1977:43-44).

³ A "safety bicycle" is one with similarly sized wheels, in contrast to the earlier bicycles with oversized front wheels.

Early federal attention to the poor condition of rural roads came from two sources—the Department of Agriculture and the Post Office Department. The Department of Agriculture was interested in the farmer’s ability to transport goods to market and the nearest railway station, while the Post Office’s interest was tied to the difficulties of rural mail delivery.⁴ The Post Office Department was authorized to embark on a program of rural free delivery of mail in 1893, but only along good roads in fit condition for travel. This led to strong public pressure on local governments to improve roads even though the first rural mail delivery by automobile did not begin until 1915.

On a parallel track and also in 1893, Congress first designated funds for rural roads through the Agricultural Appropriation Act of 1893, and established the Office of Road Inquiry under the Department of Agriculture. With an annual budget of only \$10,000, the staff of two made inquiries about the construction and management of road systems, but had neither the funds nor the authority to actually build roads (the duties, growth, and evolution of this office into the FHWA are discussed below).

In every session of Congress from 1903 to 1916, Congressmen introduced bills for direct federal aid to road construction, each unsuccessful. Among the 60 bills introduced in 1912 alone, the Post Office Appropriation Act of 1912 offered indirect federal aid for road construction, as it directed the Postmaster General to work with the Secretary of Agriculture on the improvement of about 50 miles of post roads within each state. The experiment was only partially successful, as only 13 states accepted the offer of federal money. Some states cited the required matching funds as their reason for refusing, some objected to the federal ban on using convict labor, and a few states disagreed with the federal requirement of an eight-hour work-day (FHWA 1977:84-86, 201; Hewes 1946:44). The more successful portion of the legislation set up a joint Congressional committee to investigate direct federal aid to highway construction, and the findings of the committee contributed to the Federal Highway Act of 1916, discussed below (FHWA 1977:80-82).

“THE ROADS WERE NO GOOD”

Americans respond to new inventions with enthusiasm. In our lifetimes, we understand how quickly the personal computer, the fax machine, and the microwave oven became necessities instead of novelties, and our grandparents and great-grandparents treated the automobile in the same fashion. As late as 1896, the Barnum and Bailey circus included an automobile “as its main curiosity, with top billing over Jumbo the Elephant, the giant, and the fat lady” (Bourne 1995:113). In 1900, only four years after the automobile made its appearance with the circus sideshow, about 4,000 cars were made in this country, and by 1910, annual production had risen to 187,000 automobiles per year (Figure 1). Census officials included auto manufacturing under the “miscellaneous” category in 1910, perhaps not understanding the potential size of the new industry.

The year 1907 saw the introduction of Henry Ford’s popular Model T (Figure 2). One image of the new machine, at least as displayed humorously on the cover of the *Life Magazine* “Motor Car” issue that year, was as a menace (Figure 3). Initially, automobile ownership was predominantly an urban phenomenon. Although rural folks may not have thought of automobiles as a menace, rural adoption of the automobile

⁴ John Wanamaker (1838-1922) served as Postmaster General from 1889 to 1893. He owned large department stores in New York and Philadelphia, and certainly recognized that better postal roads could open a vast rural mail-order market to businesses such as his.

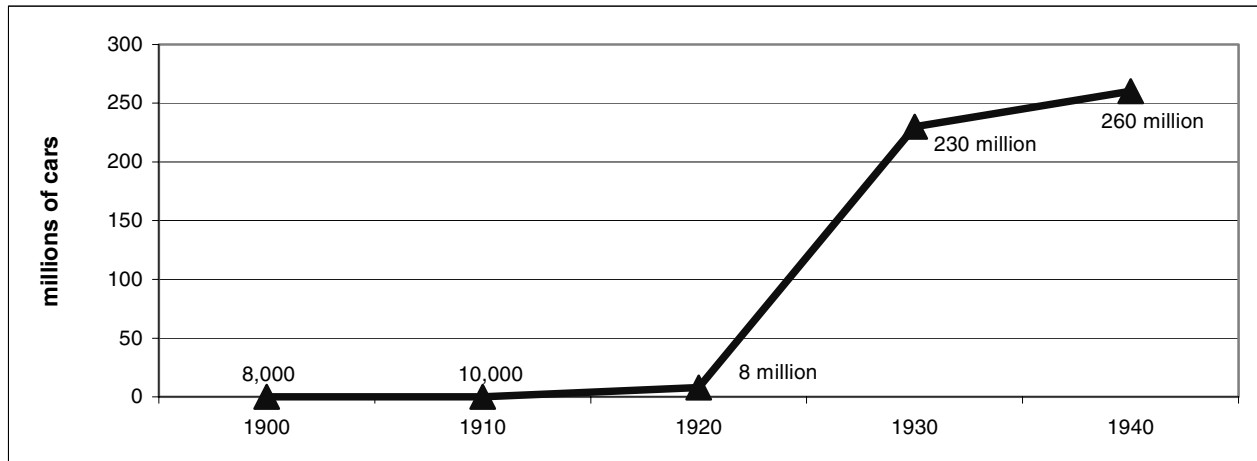


Figure 1. Growth of Automobile Ownership in the United States, 1900-1940



Figure 2. A Model T Ford in a Tucson Neighborhood, circa 1915

and by association, support for improved roads, was slow in coming until farmers became automobile owners and joined the campaign to “get the farmers out of the mud” (FHWA 1976:57). After Ford perfected full assembly line production in 1914, more than half a million automobiles were sold in 1916⁵ (Bourne 1995:114-116). In the 1920s, the number of registered automobiles more than tripled, and by 1929, the authors of the well-known sociological portrait of America, *Middletown*, noted that automobile ownership had “reached the point of being an accepted, essential part of normal living” at all social levels (Bourne 1995:118; Liebs 1985:20). The editors of *Life Magazine* confirmed this trend in their cover illustration for the “Automobile Number” in January 1925. In a much smaller, and not at all menacing, automobile, a cartoon family heads for a picnic, gleefully crying out, “We’ve got one now!” (Figure 4).

⁵By 1920, one out of every two cars in the world was a Model T Ford, and between 1907 and 1927, more than 15 million Model Ts were built (Bourne 1995:116-7).

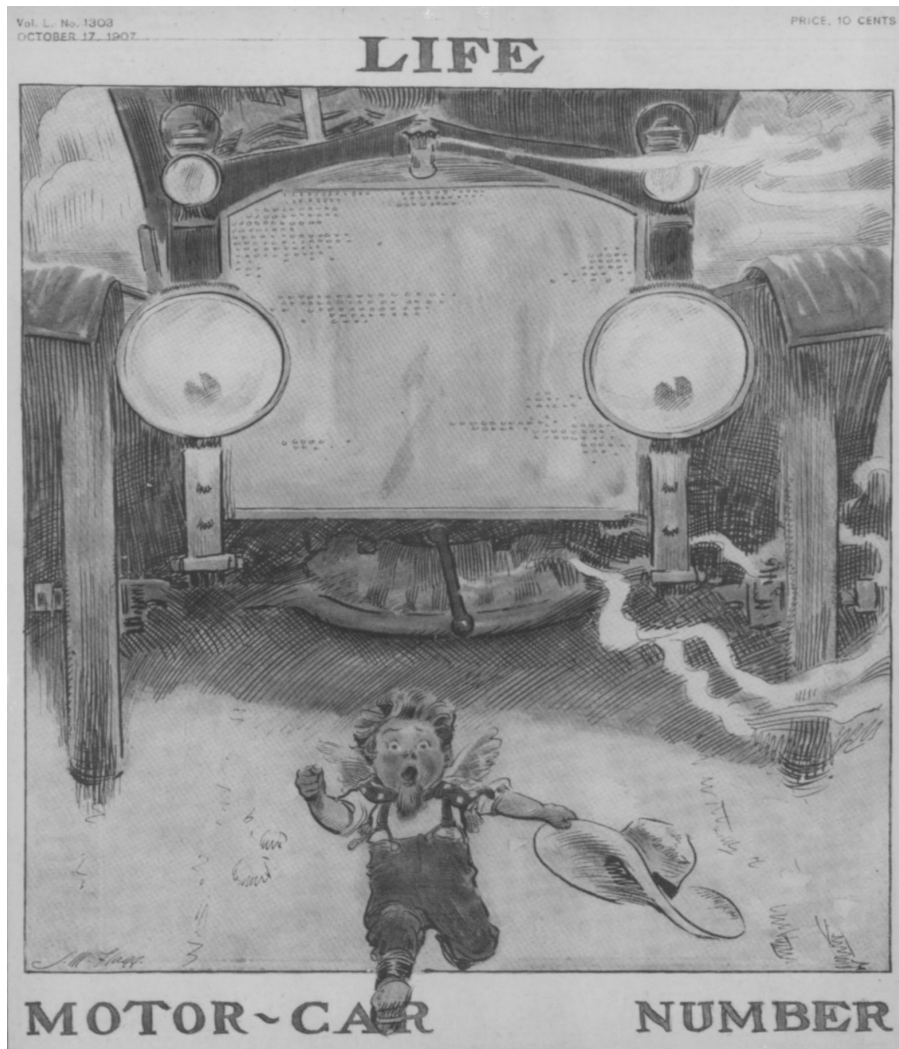


Figure 3. *Life Magazine*, 1907

The citizens of Arizona also took to the new invention quickly. One source claims the first automobile in the Territory arrived in Tucson “at the turn of the century” (Federal Writers Project 1989:114). Another of the first commercially manufactured automobiles to come to Arizona arrived in Phoenix in 1900 as a prize in a publicity contest sponsored by a San Francisco newspaper. The local newspaper opined that the prize auto posed no threat to the horse. Only a year later, the local Phoenix newspaper suggested that the horse had become “an old-fashioned standby” to the 20 automobiles in the Arizona Territory (Rodda 1992:1).

By 1913, there were 17 automobile dealers in Phoenix and 646 cars registered in Maricopa County. Vehicle registration rose to 11,539 in 1920 and to more than 53,000 in 1929 (one automobile for every three people in the county) (Luckingham 1989:81). In 1910, the first traffic regulations in Phoenix and the first traffic policeman required the 382 registered automobiles to stay on the right side of the road and obey new speed limits (12 miles per hour [mph] in the central business district and 15 mph elsewhere). Several drivers received speeding citations for exceeding 20 and 30 mph, and residents complained of automobiles racing up and down north Central Avenue in the evenings “driving sober people off the streets” (Davis 1976:10; Luckingham 1989:52).

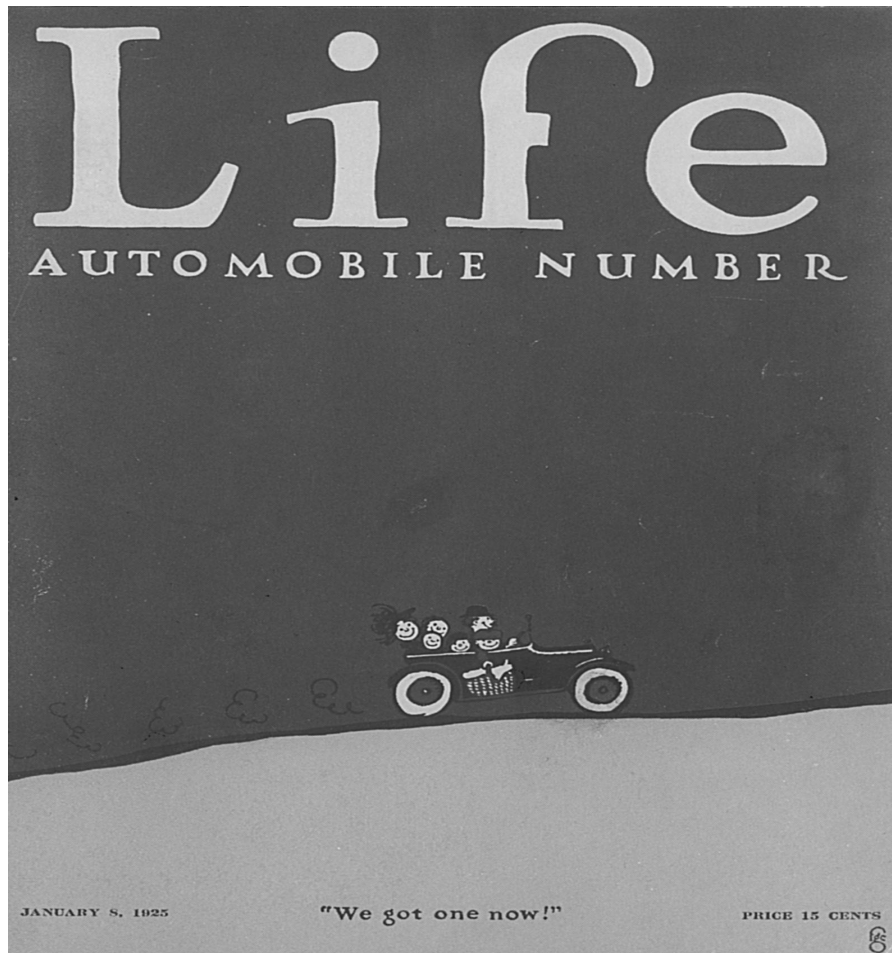


Figure 4. *Life Magazine*, 1925

Henry Ford built cars, not roads. The rural roads in existence at the turn of the century had been built for wagon traffic, and the lack of good rural roads to carry their new machines stymied the increasing numbers of automobile enthusiasts. In 1903, the first duo to travel across the continent from San Francisco to New York by automobile found the best roads to be improved only with gravel surfacing.⁶ Not only did Dr. H. Nelson Jackson and his chauffeur Sewell K. Crocker encounter poor roads, they accomplished the two-month cross-country journey without benefit of through routes, reliable road maps, road signs, route markers, and roadside services (FHWA 1977:60-61). Their experiences were similar to those of another early cross-country traveler. Henry Joy, president of the Packard Motor Company, received the following directions from a man in Nebraska, “Drive west from town until you reach a fence. Open the fence, drive through and close it. Do this several times.” Eventually, the fences ran out and Mr. Joy looked out on “nothing but two ruts across the prairie” (Patton 1986:40).

The paucity of built roads that Mr. Joy encountered on the plains of Nebraska echoed the road situation in Arizona. A 1912 map of Arizona includes wagon roads and railroads, but only two “highways” (Pocket Map 1⁷). One of these highways extended from Douglas north through Tucson, Phoenix, Prescott, and

⁶The first coast-to-coast truck journey was made in 1911.

⁷ The *Arizona Highways Magazine* did not specify what sources were used to prepare this map in 1987. The contemporaneous 1912 *Rand-McNally New Commercial Atlas Map of Arizona* depicts topographic features and

Flagstaff, terminating at the Grand Canyon. The other extended east from Yuma through Phoenix and Globe, terminating at Clifton. The mileage of highways was far outnumbered by the mileage of wagon roads and despite their designation as official Territorial Highways, these roads were unpaved. A year later, the Arizona Good Roads Association published Arizona's first book of road maps and touring information. A photograph on the frontispiece of this little book shows an early automobile on a dirt road only inches wider than the axles of the auto. The caption reads, "Enroute to Castle Hot Springs Over Best Road in the Southwest," which was only a single-lane, graded dirt road.

Publicity has often contributed to social change in the United States. In 1904, just one year after the first automobile traveled across the country, the American Automobile Association (AAA) sponsored the "St. Louis World Fair Motor Caravan," a pilgrimage of autos traveling from East Coast cities to the Louisiana Purchase Centennial Exposition in St. Louis. The next year, AAA sponsored the first of six annual cross-country tours to highlight the difficulties of traveling long distances on rural roads (FHWA 1977:61-62). In 1916, two women suffragists successfully motored around the country for 10,700 miles in six months, using their car as a speaking platform. Poor roads caused them to get lost four nights in the deserts of Arizona and New Mexico (Scharff 1992:86-87). Simply put, in the words of one 80-years-old man's reminiscing about the early 1920s, "The roads were no good" (Scott and Kelly 1988:18).

THE U.S. OFFICE OF ROAD INQUIRY

Twentieth-century federal involvement in road building started out with a tinkle of coins in 1893. That year, the Agriculture Appropriation Act included \$10,000 for "inquiries in regard to the systems of road management throughout the United States." This appropriation established the U.S. Office of Road Inquiry, an office that was designated as temporary but eventually evolved into the FHWA. The first "Special Agent and Engineer for Road Inquiry," General Roy Stone,⁸ was one of the personalities that greatly contributed to the miracle of twentieth-century road building. Trained as a civil engineer and a well-known booster of good roads, Stone proposed as early as 1892 that Congress establish a National Highway Commission, and he founded the National League for Good Roads in 1893. Stone and his staff of one clerk used the small annual appropriations in innovative ways to gather and spread information from all the states and territories on road building materials and highway laws (Housley 1996:12).

In 1896, Stone created "object lesson" roads, an innovative idea with long-reaching influence. In order to educate both road builders and the public about good roads, Stone worked with agricultural college experiment stations to build short stretches of demonstration roads known as "object-lesson" roads. Ironically, the road-building teams often traveled by railroad from one location to another. Due to the Office of Road Inquiry's limited budget, Stone convinced road equipment manufacturers to donate equipment, and raised funds from local authorities and private individuals to finance the construction materials. After Stone left the Office of Public Inquiry in 1899 to accept the presidency of the National League for Good Roads, the Office continued to build object lesson roads (FHWA 1977:44-48). Stone's successor described their effect in 1904.

The people desire instruction by the building of object lesson roads and are willing to bear the expense incident thereto . . . In practically every instance some measure of progress resulted from the object lesson. It would seem to be conservative to estimate that an average of at least 10 miles

railroads, but no roads, indicating that cartographers did not think the roads were worthy of much attention.

⁸Originally from New York, General Stone served in the army in both the Civil War and the Spanish American War, taking a leave of absence from the Office of Road Inquiry for the latter engagement.

of improved highways are constructed as a result of the building of each of these roads (FHWA 1977:65).

In 1904, the Office of Public Road Inquiries conducted the first inventory of all roads in the United States outside cities, and the agency repeated this inquiry at five-year intervals. From the 60,000 questionnaires returned by county authorities, the Office tabulated road mileage according to surface type, and found that of the 2 million miles of rural public roads in the United States, only 7 percent were surfaced with gravel or stone. That is, 93 percent of the rural roads in the United States in 1904 were dirt roads. It is not surprising that Dr. Jackson and his chauffeur had encountered only a few gravel roads in their 1903 trek from San Francisco to New York (FHWA 1977:50, 88).

When the agency achieved permanent status in 1905 as the Office of Public Roads, one of the first road scientists in the United States assumed the directorship. An American trained at the French Laboratory of Bridges and Roads, Logan Waller Page had served as the director of the road materials laboratory at Harvard. As geologist for the Massachusetts State Highway Commission, Page had conducted the first extensive investigations of road building materials in this country. Page continued the public education work of the Office of Public Roads, publishing articles in rural papers, setting up exhibits at national expositions and fairs, and organizing additional Good Roads trains from 1911 to 1916. In 1912 alone, 27 lecturers from the Office of Public Roads spoke to more than 200,000 people in 37 states on the benefits of good roads (FHWA 1977:76).

Not only did the country lack good roads, it also lacked engineers trained in the building of roads. Engineers and surveyors experienced in railroad construction took up the work of road building. After about 1904, the Office of Public Roads sent its own staff of engineers across the country to advise counties on modernizing their road operations, and through the decade, the Office assisted 144 counties in 28 states (out of more than 3,000 counties in the nation). Director Page hired young civil engineering graduates as “students” within the Office to learn practical road building, and about half of these student engineers later worked for county and state road departments. Page also furnished advisors to the universities to help them set up courses in highway design and construction (FHWA 1977:73-75).

As one of his important contributions to road construction, Page initiated “stage construction,” that is, the initial improvement of a dirt road by grading, and when funds became available, subsequent use of the dirt road as “the best possible foundation for further improvements with a hard surface.” With his extensive background in the science of road surfacing materials, Page directed his staff to experiment with clay, oil, concrete, and paving brick, and the construction specifications published by his office became industry standards adopted by most state highway commissions (FHWA 1977:66, 76, 191).

A most influential personality in federal road administration was Thomas Harris MacDonald, who served as top highway administrator for 34 years under seven presidents from 1919 to 1953 (Table 1). When he assumed the position of Chief of the Bureau of Public Roads in 1919, there were about 2.5 million miles of rural roads in the country, largely unpaved and mostly unconnected. At his retirement in 1953, the country boasted 3.5 million miles of paved, connected interstate routes. MacDonald’s interest in roads began as early as college when he wrote his undergraduate thesis describing the highway needs of farmers, and one of his first jobs was his appointment as Iowa State Highway Commissioner in 1907 at the age of 26. During his years in Iowa, MacDonald worked closely with other state highway officials in the American Association of State Highway Officials (AASHO), an important organization described below. One of the hallmarks of his tenure as Chief was an emphasis on cooperation between the states and the federal government in road building.

<p style="text-align: center;">TABLE 1 EVOLUTION OF THE OFFICE OF ROAD INQUIRY, 1893-1956</p>			
Year	Organizational Title	Department	Head Administrator
1893	Office of Road Inquiry*	Agriculture	General Roy Stone, <i>Special Agent and Engineer for Road Inquiry</i>
1899	Office of Public Road Inquiry*	Agriculture	Martin Dodge, <i>Director</i>
1905	Office of Public Roads	Agriculture	Logan Waller Page, <i>Director</i>
1915	Office of Public Roads and Rural Engineering	Agriculture	Logan Waller Page, <i>Director</i>
1919	Bureau of Public Roads	Agriculture	Thomas MacDonald, <i>Chief</i>
1939	Public Roads Administration	Federal Works Agency	Thomas MacDonald, <i>Commissioner</i>
1949	Bureau of Public Roads	Commerce	Thomas MacDonald, <i>Commissioner</i> , 1949-1953 Francis du Pont, <i>Commissioner</i> , 1953-1955 Charles Curtiss, <i>Commissioner</i> , 1956
<p>* A temporary federal agency that was given permanent status in 1905. Source: FHWA 1976:191-195, 213-214</p>			

GOOD ROADS AND HIGHWAY BOOSTERS

By 1910, more than 100 national and local organizations promoted good roads in the United States, including AAA, which had been founded by motorists in 1902. The most aggressive of the six national organizations was the National Good Roads Association. One year after its founding in 1900, this association had collected sufficient monetary and in-kind donations from civic groups, road machinery manufacturers, construction material suppliers, railroad companies, and individuals to assemble several “Good Roads Trains,” each complete with road building machinery, road experts, and press representatives. From 1902 to 1903, these trains traveled to several parts of the country, using General Stone’s object lesson roads to promote construction of good roads (FHWA 1977:48-50).

During the initial years of highway improvement, the railroads supported the Good Roads movement, reasoning that improved roads would increase railroad freight volumes by making it easier to get products to rail shipping points. In 1922, Bureau of Public Roads Chief MacDonald touted roads as “the links which, eventually united, will constitute a new means of transportation, no less important to the country as a whole than offered by the railroads” (FHWA 1977:113). By the late 1930s commercial truck traffic increased to the point of competing with the railroads for shipping revenues, and the railroads became critical of expenditures for highway construction (FHWA 1977:250; Goddard 1994).

The National Highways Association was a second powerful organization on the national scene that coordinated the work of state good roads associations and lobbied for a national system of highways. In its mission statement of 1912, the National Highways Association put forth lofty goals and aimed at no

less than the preservation of the Union. The membership of the National Highways Association convened to

favor, foster, and further the development of National Highways and Good Roads everywhere in the length and breadth of these United States of America, and to secure the benefits—social, moral, commercial, industrial, material, educational, and personal—in the progress and uplift of the American people which follow in the train of easy intercommunication and transit between the great centers of population and distribution and the great rural productive areas of the Nation, and to bind the States together in a common brotherhood, and thus perpetuate and preserve the Union (Arizona Good Roads Association 1914).

A map published by the National Highways Association in 1914 proposed 50,000 miles of an interconnected, national system of highways. On this map, the 3,324-mile-long, coast-to-coast “Southern Highway” followed the route of the Territorial Highway across southern Arizona, through Douglas, Tucson, and Yuma. The 2,400-mile-long “Santa Fe Highway” in general followed the route of Beale’s Wagon Road and the future U.S. Highway 66 across northern Arizona. The 1,800-mile-long “Missouri-Arizona Highway” branched from the Southern Highway at Phoenix and headed east through Globe, in general following the route of the future U.S. Highway 60. East of Globe, the highway headed due northeast to Albuquerque (Arizona Good Roads Association 1914).

After about 1910, road boosters formed highway associations that named and promoted specific long-distance highway routes. These boosters designated their routes with grandiose and nostalgic names such as the Old Spanish Trail, Pike’s Peak Ocean to Ocean Highway, Jefferson Highway, and Parks to Parks Highway (Patton 1986:44; Kaszynski 2000:40-42).

The Lincoln Highway Association, the first and one of the most ambitious of these organizations, aimed to build a coast-to-coast paved highway from Washington, D.C. to San Francisco. Organized in 1913, the Association capitalized on American history and selected a route incorporating parts of historic roads and earlier trails such as the Cumberland Road and the Pony Express trail. By 1914, under the leadership of Henry Joy, president of the Packard Motor Company and the man who had found “nothing but two ruts across the prairie” on his cross-country trip years earlier, the Association adopted the slogan, “See America First.” The Association raised funds to build the Lincoln Highway by donations from businesses, politicians, and organizations. Towns eager to be included on the route completed “seedling miles” to promote interest and donations, another use of General Stone’s concept of object lesson roads (Liebs 1985:18; Patton 1986:39; Scott and Kelly 1988:6).

Each of these highway associations vigorously promoted their own routes, and motorist clubs often erected mileposts and primitive directional signage along the roads in their areas. By the middle of the 1920s, about 250 highways named and promoted by boosters crossed the United States and the jumble of non-connecting roads and non-standard signage confused travelers. Symbols marked some routes, such as the silhouette of Chief Pontiac’s head that marked the Pontiac Trail, but most routes were marked simply with stripes of paint on a fence post at the edge of the road (Figure 5). In the words of William Rishel, a colorful highway advocate who worked for decades promoting good roads in Utah,

Salt Lake City was perhaps blessed, or should I say cursed, with more highway associations than any other city in America. At one time, there were no less than fourteen highway and trail associations claiming State Street as their own particular route. The telephone and light poles looked like barber signposts with the associations’ different identification bands painted in different colors (Rishel 1983:90).

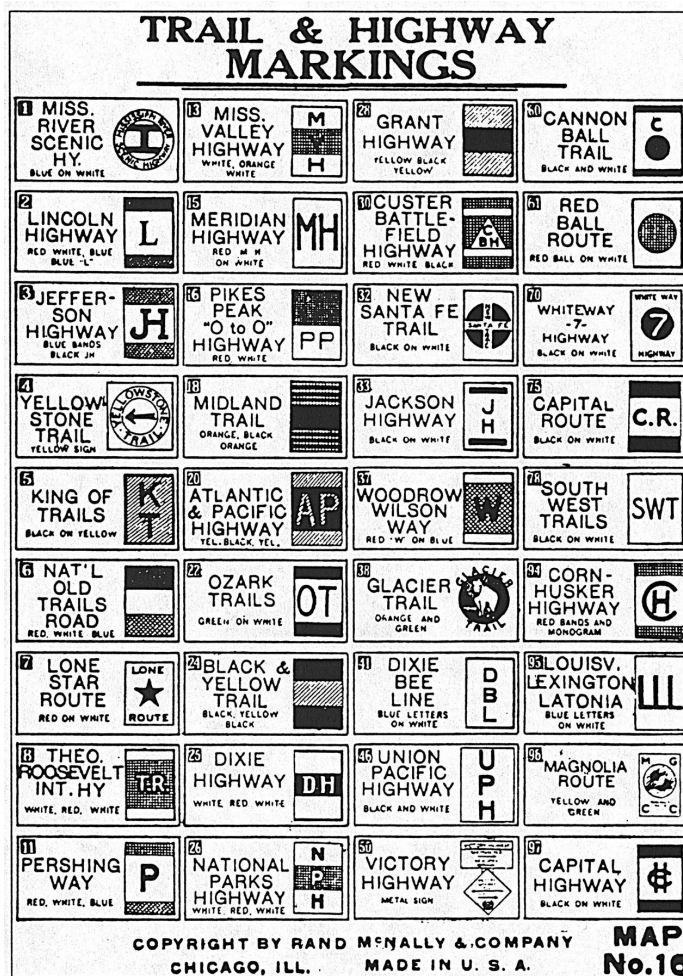


Figure 5. Trail and Highway Markings, 1925

In the Southwest, an ersatz cowboy is sometimes described as “all hat and no cattle,” and the booster highway associations can be summed up as “a lot of talk and not much road.” These early attempts to develop long-distance highways rounded up public enthusiasm for long-distance routes, but the associations actually constructed only a few miles of road. Even the most famous of the long-distance highways begun by boosters reached completion only after the federal government provided financing, as the Bureau of Public Roads completed the Lincoln Highway in 1923 (Patton 1986:45).

In Arizona, the Office of Indian Affairs, not the highway association, built the steel girder bridge across the Colorado River at Yuma in 1914-1915. Built to provide a river crossing to the Yuma Indian population, the bridge also carried the Ocean-to-Ocean Highway across the Colorado River from California into Arizona. Emblazoned with bold white capital letters announcing “Ocean-to Ocean Highway, Yuma, Arizona,” the two-lane bridge of steel girders was the only bridged crossing of the lower Colorado River at the time of its construction (American Planning Association 1997). In addition, the State Highway Engineer, not the highway association, built the road from Yuma to Springerville along the route designated as the “Ocean-to-Ocean Highway,” primarily because Arizona had already designated the route as parts of two Territorial highways.

The historical significance of the booster highway associations lies in their pioneering work in assembling long-distance, cross-country routes and designating them as highways. The establishment of a national,

uniform numbering system for highways recognized their work, and often incorporated the named routes into the numbered system. In Arizona for example, the National Old Trails Highway became U.S. Highway 66 (compare Pocket Map 2 and Pocket Map 3).

COUNTY AND STATE DOLLARS

During the first decade of the twentieth century, county officials held direct responsibility for rural roads within their jurisdictions. These officials tended to build and improve roads to and from county seats with an eye to serving the most populous areas. These county roads created a distinctive pattern on the landscape.

By the third quarter of the nineteenth century, rural roads were primarily used to transport goods between farm and market. As a result, each population center and rail shipping point became the hub of a star-like pattern of feeder roads that permitted the delivery of agricultural goods (Liebs 1985:16).

To be sure, these roads often followed section lines surveyed by the General Land Office, but county officials tended not to be concerned about connecting their county roads with other routes within the state. William Rishel described the situation in Utah, “They would spend taxes there, not giving a rap whether we could get over the county line into another county” (Rishel 1983:81).

In order to begin the process of connecting roads across county lines, county governments looked to the states for funding. As early as 1891, a New Jersey law extended at least some of the financial responsibility for road construction to the state, and by 1917, all states had followed New Jersey’s example of providing some form of state funding for road construction (FHWA 1977:239). In 1919, the state of Oregon began taxing gasoline sales to pay for highway construction within the state, and the new tax quickly spread to all the other states. Arizona implemented a similar tax in 1921. In addition, states collected other fees relating to highway usage, such as registration fees. By the mid-1940s, these highway user revenues had become the primary state funding source for highway construction and maintenance, largely replacing the property taxes that had funded nineteenth century road construction and maintenance (Hewes 1946:46-47).

In conjunction with providing state dollars for road construction, many states established state highway departments. Massachusetts established the first state highway commission in 1893, and by the time Congress passed the 1916 Federal Aid Road Act requiring states to establish highway commissions, 32 states had already done so (FHWA 1977:43). A Territorial Engineer had been appointed in Arizona in 1909, and the first State Highway Engineer was appointed at statehood in 1912.

In 1910, the director of the federal Office of Public Roads, Logan Waller Page, invited representatives of good roads associations, state highway departments, and railroads to form a new national organization—the American Association for Highway Improvement (the named was shortened in 1912 to the American Highway Association). Although several state highway departments participated in the American Highway Association, state officials felt the need for “full and frank consideration of questions, particularly those of technical character untrammelled by commercialism or popular prejudices” (FHWA 1977:79). In December 1914, they organized as AASHO to “bring some sense to the every-which-way condition of highway construction” (Scott and Kelly 1988:13). From the first year of this organization, AASHO has worked to set standards for highway construction, develop administrative and engineering

principles, and recommend federal legislation.⁹ Important AASHO contributions to highway improvement included the landmark 1921 Federal Highway Act, the standardization of road signage in the 1920s and 1930s, and national standards for road maintenance set in the 1940s.

FEDERAL AID AND THE SEVEN PERCENT SYSTEM

The concepts and details of federal financial responsibility for road construction have evolved considerably over the years (Table 2). The first substantial levels of federal funding date from 1916, but those appropriations pale in comparison to the tax revenues that the federal government provided for development of the interstate highway system in the mid-twentieth century.

TABLE 2 IMPORTANT FEDERAL ROAD LEGISLATION, 1893-1956			
Year	Title	Dollars	Important Provisions
1893	Agricultural Appropriation Act	\$10,000	Set up and directed temporary Office of Road Inquiry to make inquiries about the construction and management of road systems, and to publicize findings
1912	Post Office Appropriation Act	\$500,000	Required 66 percent matching funds from states, directed counties to work with Secretary of Agriculture, banned use of prison labor in building roads; only 13 states accepted the federal money
1916	Federal Aid Road Act	\$5 million in 1917 increasing to \$25 million in 1921	For construction and maintenance of rural post roads; first to set up multi-year funding plan; Section 8 = \$10 million for forest roads, 1917-1926; required State Highway Departments and 50 percent matching funds from states
1921	Federal Highway Act	\$75 million	Established “seven percent system;” required federally funded roads to connect across state lines; 50 percent matching funds from states
1933	National Industrial Recovery Act	\$400 million	Extended federal funds beyond the “seven percent system” to secondary and urban roads; required no state matching funds; required 30-hour limit on work week and banned use of prison labor
1934	Hayden-Cartwright Act	\$200 million	Re-established requirement of state matching funds; set aside funds for highway planning
1935	Emergency Relief Appropriation Act	\$200 million	Required state matching funds; provided additional \$200 million to improve railroad crossings that did not require matching funds
1944	Federal-Aid Highway Act	\$1.5 billion	Designated National System of Interstate highways
1956	Federal-Aid Highway Act	\$27 billion	Set up Highway Trust Fund to provide long-term funding for interstate highway system from federal excise and gasoline taxes; required only 10 percent state matching funds
Source: FHWA 1976			

During January 1916, the chairman of the newly formed House Committee on Roads drew upon lessons from the past to establish policies for the future in his road bill. With enthusiastic support from AASHO, the Secretary of Agriculture, Postmaster General, and Office of Public Roads, the landmark legislation was passed as the Federal Aid Road Act of 1916. The act established a long-term approach to building roads and provided annual appropriations of \$5 to \$25 million.

In a similar provision to the 1912 post road program, the 1916 Act restricted a portion of the annual federal allocations to those roads used to transport the mail. However, remembering the difficulties of the

⁹The organization is known today as the American Association of State Highway and Transportation Officials (AASHTO), and remains a powerful policy-making and lobbying organization.

1912 post road program, the bill required states to establish state highway departments to work with federal officials, eliminating direct federal contact with counties. The act also earmarked funds for building roads in national forests. Reflecting the presidential vetoes of Jackson and Madison a century earlier, the 1916 Act appropriated federal money to build roads but allowed ownership and maintenance of these roads to remain with the states, counties, and local governments, and allowed state highway departments to initiate and manage road projects.

In addition, the 1916 Act prohibited the use of federal road aid funds in cities with a population of more than 5,000 because urban streets were regarded as a local responsibility. This restriction remained in effect until 1936. Temporarily ending a long-term Congressional debate, the Act required that “all roads constructed under the provision of this Act shall be free from tolls of all kinds” (FHWA 1977:241; Seely 1997:13).

The 1916 Federal Aid Road Act had a great impact on road building across the country, but created challenges for state highway departments. In 1919, the president of AASHO expressed some of the difficulties encountered in its implementation.

They are expecting the States which had no highway organizations three or even two years ago, which had done no preliminary work and in some of which hardly a mile of modern rural highway had ever been built, to create an organization full sprung from the earth . . . and to build instantly hundreds of miles of modern roads costing millions upon millions of dollars. In the older States in the highway game, better prepared with organizations and contractors, and with some knowledge of materials and construction conditions, they are asking us to double, triple, or quadruple our annual output of roads (FHWA 1977:104).

In 1921, the Executive Committee of AASHO met to draft a bill that would continue the principles of the 1916 Act but correct its weaknesses, and that piece of federal legislation is the most significant legislation for road construction in the first half of the twentieth century. The Federal Highway Act of 1921 systemized highway construction by requiring each state to designate a state highway system comprising not more than 7 percent of all rural roads within the state, and allocated federal dollars only to that 7 percent system. Further, the 1921 law required the chosen roads to connect with other federally funded roads across state and county lines. The state highway departments, not the Bureau of Public Roads, selected the routes to be included in the seven percent of state roads to be federally funded. In the opinion of one Bureau of Public Roads official, “It is a credit to the State highway departments of twenty-five years ago that their selection . . . was prompt, intelligent, and sound. Their original seven percent system today is the fundamental framework for the nation’s highways” (Hewes 1946:45).

In contrast to the maximum \$25 million annual appropriation under the 1916 act, the 1921 Act carried a first year annual appropriation of \$75 million that was renewed annually through 1932, and required states to match federal funds in a one-to-one ratio, thus providing 50 percent of the funding. In recognition of the greater distances and greater acreage of federal lands in western states, the Act increased the proportion of federal matching funds in states with large sections of federal land. In addition, federal highway dollars were also appropriated for the National Park Service, Forest Service, and Bureau of Indian Affairs to build roads on federal lands managed by those agencies¹⁰ (FHWA 1977:247).

¹⁰ In 1912, Congress stipulated that 10 percent of the revenue from national forests be used to build roads in the forests. The Chief Forester turned to the Office of Public Roads for technical assistance, and at about the same time the Department of the Interior also asked for technical assistance in planning and building roads in the national parks. To address these requests, the Director of the Office of Public Roads organized a Division of National Park and Forest Roads (FHWA 1977:75). Because so much land in Arizona is federal, the road construction programs of

The task of coordinating the “7 percent system” selected by the 48 state highway departments fell to the Bureau of Public Roads. In 1923, the Bureau published a national map of the Federal-Aid Highway System of just less than 170,000 miles of highway, estimating that 90 percent of the population of the country lived within 10 miles of one of the roads in the system. By 1925, over a quarter of the miles in the federal aid highway system had been improved (FHWA 1977:108-109).

NUMBERING THE HIGHWAYS

In 1924, the same year that inaugurated the *Rand-McNally Road Atlas*, AASHO initiated an important innovation in twentieth-century road policy. At their tenth annual meeting in November that year, the Association petitioned the Secretary of Agriculture to undertake

the selection and designation of a comprehensive system of through interstate routes, and to devise a comprehensive and uniform scheme for designating such routes in such a manner as to give them a conspicuous place among the highways of the country as roads of interstate and national significance (Scott and Kelly 1988:13).

That is, AASHO asked the federal government to eliminate the nationwide jumble of private highway signs and multi-striped poles and to replace the confusion with a uniform numbering system similar to systems that had already been adopted in Wisconsin and Oklahoma. In response, the Secretary of Agriculture appointed a joint board consisting of three engineers from the Bureau of Public Roads (including Chief MacDonald) and 21 state highway engineers. The Secretary charged the joint board to designate a national system of highways using existing roads, formulate a uniform numbering system, and adopt a standardized system of signs and markers for the new highways.

The first task, selecting existing roads to create a national system of highways, was perhaps the most difficult for the engineers. The joint board chose to make their deliberations on this topic away from the clamoring of the private highway associations and the local communities. The board held no public hearings.

As their second task, the joint board assigned even numbers to east-west highways, and multiples of 10 to long-distance routes (for example, 60, 70, 80). North-south highways received odd numbers, and the major north-south routes received numbers ending in one and five (FHWA 1977:408; Liebs 1985:19).

The third task of the joint board, that of adopting standardized signage, combined earlier investigations and decisions. In 1922, three state highway officials from Wisconsin, Minnesota, and Indiana had made a fact-finding trip through several states to look at highway markings and traffic control signage. Their report presented to the annual meeting of AASHO in 1924 established distinctive geometric shapes for signs, such as the octagon for stop signs, the circle for railroad crossing signs, and the diamond for cautionary signs. Each of these traffic signs was to be white, with black lettering and a black border. The report also suggested that each state design and mark state routes with distinctive route markers.¹¹ Also in

these agencies is an important element of history of road building in the state, but is beyond the scope of this overview.

¹¹A 1930s photograph album of state highway signs displays several images still familiar to the traveler of today. The Wyoming highway sign carried the cowboy on a bucking bronco that remains on the Wyoming license plate, while the Louisiana sign included the familiar pelican and the Pennsylvania sign was in the “keystone” shape (Phillips and others 1996:plate 79).

1924, another interested group, the National Conference on Street and Highway Safety, had recommended the use of color on traffic signs: red for “stop,” green for “proceed,” and yellow for “caution.” The joint board combined the recommendations of these two groups, and added the now-familiar shield-shaped sign to mark the newly designated U.S. routes. The Secretary of Agriculture approved the joint board’s recommendations in 1925, and asked AASHO to put the plan into operation in each of their states.

In 1927, AASHO published the first national manual detailing traffic control signs and markings for rural roads, the *Manual and Specifications for the Manufacture, Display, and Erection of U.S. Standard Road Markers and Signs*. Three years later, the National Conference on Street and Highway Safety published a similar manual, incorporating most (but not all) of the AASHO recommendations and adding information on urban signs and markings. It was not until 1935 that a joint committee of AASHO and the National Conference on Street and Highway Safety wrote a single manual for both urban and rural applications. Approved by the Secretary of Agriculture, the *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD) was revised in 1939, 1948, and 1955. The 1955 version established the white letters on a red octagon of today’s stop sign, and the black letters on a yellow triangle of today’s yield sign.

HIGHWAY APPROPRIATIONS DURING THE GREAT DEPRESSION

In the 1920s, federal policy had focused on improving the American road system. In contrast, federal policy in the 1930s focused on putting people to work, and many went to work on road construction projects. Although American industries suffered greatly during the years of the Great Depression, the road-building industry was one of the industries least affected by the Depression due to more than a billion dollars of federal support in the 1930s. The employment benefits of road work extended beyond the actual job site. A 1932 Bureau of Public Roads study determined that for every person working on a road construction job, “seven others were indirectly employed making cement, aggregates, and [road building] machinery and in transporting these products” (FHWA 1977:124).

By 1929, after more than a decade of federal support of highway construction, just over 90 percent of the 7 percent system of highways (also known as “federal-aid highways”) had been improved, but three-quarters of the total highway mileage in the United States remained unsurfaced. From the passage of the Federal Highway Act of 1921 until the new Roosevelt administration assumed office in 1933, Congress continued to approve annual appropriations of about \$75 million in federal aid to rural road construction. These federal appropriations required matching state funds and, after 1932, also required minimum wage standards for highway workers.

When President Franklin D. Roosevelt took office in March 1933, these semi-automatic \$75 million annual highway appropriations ceased because the administration began an extensive program of emergency public works. One of the first and most important pieces of Depression-era legislation, the National Industrial Recovery Act of 1933, granted \$400 million to the states for road construction, more than four times the annual appropriation of the previous dozen years. In contrast to earlier appropriations, this legislation eliminated the requirement of state matching funds, and allowed the states to use the federal money both on secondary roads and on urban streets that were extensions of federal-aid highways. Recognizing that most of the federal-aid highway system established in 1921 had been improved, the 1933 appropriation allowed federal aid to be used on most of the rest of the rural roads in America that remained unimproved. In order to spread the work over the greatest number of individuals, the 1933 Act limited employment to 30 hours per week per worker, gave employment preference to veterans, and prohibited convict labor.

Congress followed up the 1933 legislation with smaller appropriations in the next two years, but each still larger than a typical appropriation of the 1920s. Arizona Senator Carl Hayden, a long-time proponent of

federal aid for road construction, co-authored the Hayden-Cartwright Act of 1934, which provided \$200 million for roads. The 1934 Act also reinstituted the practice of requiring state matching funds, a requirement that had been suspended in the 1933 appropriation. In addition, the Hayden-Cartwright Act permanently extended federal aid to secondary roads and urban streets connected to federal-aid highways, and abolished the formerly mandated “dollars per mile” funding ratio (FHWA 1977:125, 490).

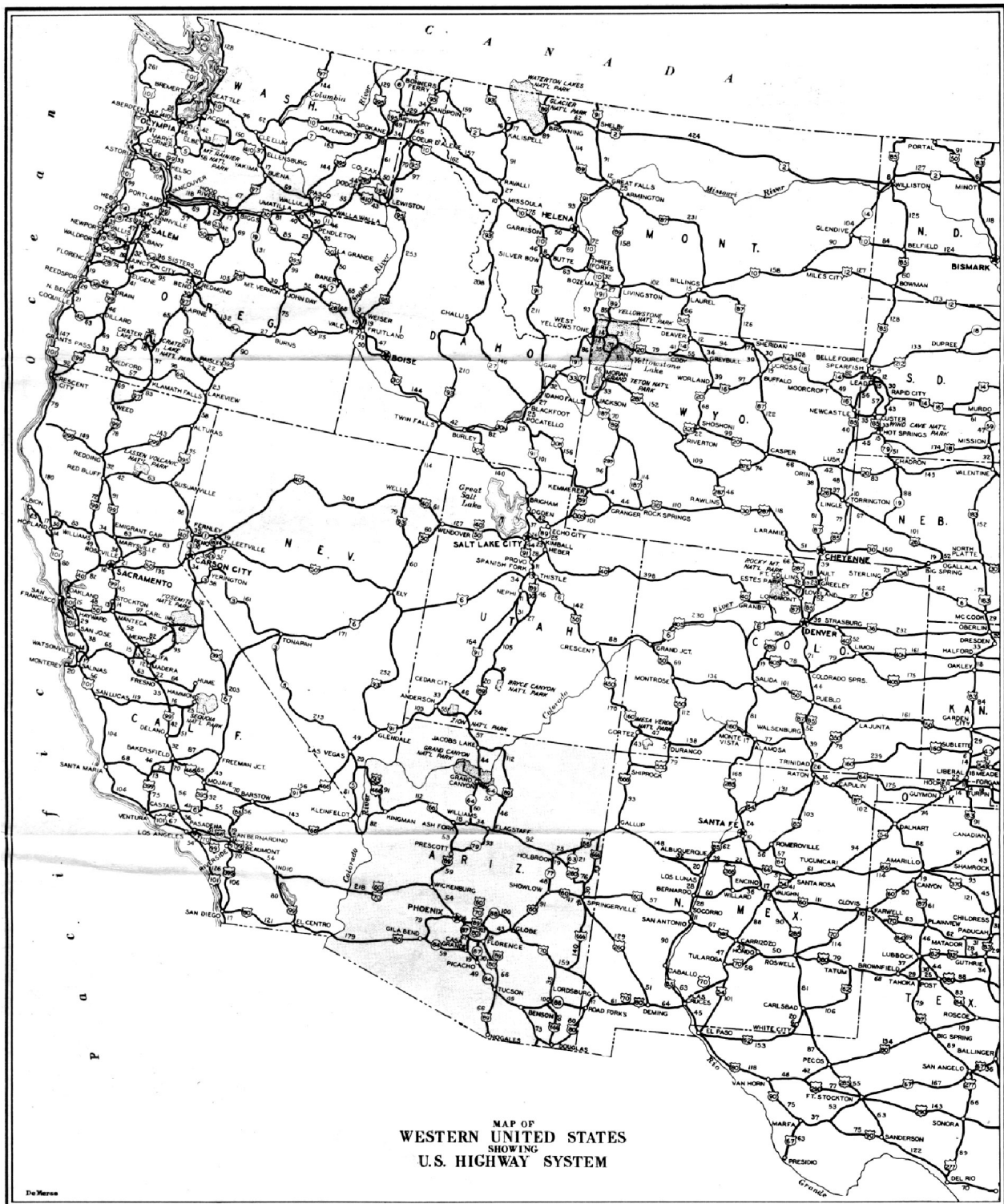
The Emergency Relief Appropriation Act of 1935 provided another \$200 million for highways. A significant component of this act was an additional \$200 million to improve the dangerous intersections where roads crossed paths with railroads (known as railroad grade crossings), and these “safety funds” did not require state matching funds. The following year, the 1936 appropriation required that railroad grade crossings be eliminated or adequately protected on *all* future projects financed by federal aid, and Congress voted an additional \$190 million each year for the next five years (1937 to 1942) to improve railroad grade crossings (FHWA 1977:124-125, 130). Arizona examples, all built in 1936, include the Highway 80 underpass in Douglas, Stone Avenue underpass in Tucson, and Winslow underpass.¹²

The 1934 Hayden-Cartwright Act contained a provision that profoundly affected the future of highways in the United States. A clause set aside 1.5 percent of federal highway construction expenditures to fund the cost of planning future highways. The Bureau of Public Roads first used the Hayden-Cartwright dollars to survey the nation’s roads in three phases, beginning in 1935. The first phase, a national road inventory, assembled information on the type, width, and condition of rural highways; the geometry of curves, grades, and sight distances; and the location of the schools, hospitals, farms, residences, businesses, and industries served by the rural highways. The second phase, a traffic survey, collected national data on traffic volume, vehicle types, origin and destination of travel, as well as a sampling of commercial vehicles detailing their weight and cargo. The information collected in the first two phases was tabulated and recorded on a variety of maps. The third phase, a national record of revenues and expenses for highways from all sources, included financial information from all levels of government, road-use studies, and examinations of the expected life span of the roads themselves (FHWA 1977:269-270).

The national planning survey had been envisioned and designed by a staff member of the Bureau of Public Roads. Herbert S. Fairbank, described as “a brilliant man, a man of broad vision . . . an engineer and a scholar, yet a practical man,” graduated from Cornell University with a civil engineering degree in 1910 and entered the Office of Public Roads as one of its earliest “student” civil engineers. From trainee to Deputy Commissioner for Research, Fairbank worked four decades in the Bureau of Public Roads. In those years, he lectured on road improvement trains, built object lesson roads, directed practical research, and foresaw the future importance of planning. Fairbank made his most important contributions to highway development in his often-anonymous writing about highway planning. In addition to writing and editing *Public Roads: The Journal of Highway Research*, Fairbank authored two important policy papers, *Toll Roads And Free Roads* (1939) and *Interregional Highways* (1944), discussed in further detail below (FHWA 1977:269).

By 1939, the work of county and state governments, private highway and good roads associations, and more than a billion dollars of federal money had produced significant results. All the primary and most of the secondary arteries of travel in the United States had been established, numbered, and paved (Figure 6; Pocket Map 3).

¹² Each of these structures has been determined to be eligible for the National Register (Fraserdesign 1987).



Source: Arizona Highway Department

Figure 6. Western U.S. Highway System, 1939

WAR TRAFFIC

The Army first tested motorized trucks for field and supply purposes in 1912. Although World War I was fought in Europe, the difficulties of transporting personnel and military goods within our own borders contributed to the nationwide interest in an interconnected system of highways. In 1922, the War Department produced the “Pershing Map,” which carried the general’s flamboyant signature across the map’s legend. This map illustrated routes of military importance, many of which coincided with the routes of the 7 percent federal aid system set up a year earlier by the states working with the Bureau of Public Roads. These military routes identified in the early 1920s became the basis for a strategic network of roads in World War II (FHWA 1977:267).

American mobilization for World War II began with defense appropriations in 1939, by which time most of the system of federal-aid roads had been built. The experience of one trucking firm illustrates the movement of people and products around the country to support the war effort.

We had a tremendous increase in business from hauling war supplies for government contractors, and in shipping engines to the West Coast, ammunition from McAlester, Oklahoma, ordnance from Kansas City and outside St. Louis, and we’d bring empty steel shell casings there to be loaded and shipped out. The war really made LeeWay Motor Freight (Scott and Kelly 1988:77).

The war’s heavy loads and heavy traffic damaged the pavement on the nation’s rural roads and highways, much of which had been built for lesser volumes of lighter automobiles. Throughout World War II, road construction and maintenance crews faced shortages of material, personnel, and road user revenues. The federal government responded by paying in full for roads to military bases and essential industrial plants, and the Bureau of Public Roads worked with the states to obtain sufficient materials to maintain the roads deemed strategically important.

In contrast, non-war-related traffic decreased during the war years, due to gasoline rationing, the scarcity of tires for civilian use, and the cessation of automobile production during the war years. Traffic in 1943 and 1944 dropped to about one half of the 1941 pre-war volume (FHWA 1977:275-277; Liebs 1985:28).

THE ROAD TO THE INTERSTATE HIGHWAY SYSTEM

Because the Federal-Aid Highway Act of 1956 funded the interstate system of highways, President Eisenhower is often named as the creator of the system. There is even a bit of folklore incorporating his Army experiences into the inspiration for the interstate system. In 1919, as a young Captain at the end of World War I, Eisenhower battled the inadequate roads, persistent mud, and endless potholes of a 56-day cross-country trip made by a convoy of 79 military vehicles from Washington, D.C. to San Francisco. At the end of the World War II, Eisenhower examined the Autobahn system of highways that had been built in Germany in the 1930s. As a result of these experiences, Eisenhower has been credited with the creation of the interstate system (FHWA 1977:241; Patton 1986:81-82).

Although Eisenhower can be legitimately credited with the first major step in funding the interstate system, the connection between presidential vision and the creation of the interstate highway system began two decades earlier and centers on President Franklin D. Roosevelt. Just over a year after Fairbank’s national planning survey began in late 1935 and before the reams of data had been analyzed, Roosevelt drew six lines across a map of the United States, three extending from east to west and three from north to south. Handing the annotated map to Bureau of Public Roads Chief MacDonald, President Roosevelt instructed the Bureau to investigate a system of toll highways for

long distance travel (FHWA 1977:272). The engineering staff of the Bureau of Public Roads took the lead in designing the system of interstate highways, and “[f]ederal engineers dominated most aspects of the nation’s highway policy for several decades, relying on an unchallenged reputation for superior technical expertise and savvy political administration that stressed cooperation [with the states] over dictation” (Seely 1997:13).

Chief MacDonald passed the responsibility to Herbert Fairbank, and Fairbank used an initial analysis of the information gleaned in the nationwide survey to make projections about toll roads. In his publication *Toll Roads and Free Roads*, Fairbank (1939) projected that the low volume of transcontinental traffic could not pay for an interstate highway system through the collection of tolls, and stated that the financial responsibility for building roads lay with local, state, and federal governments. Fairbank touted “the construction of a special, tentatively defined system of direct interregional highways, with all necessary connections through and around cities, designed to meet the requirements of the national defense in time of war and the needs of a growing peacetime traffic of longer range” (FHWA 1977:272). Thus, despite Roosevelt’s request for a transcontinental system of toll roads, the Bureau recommended that public funds finance the construction of the system.

The same year Fairbank wrote *Toll Roads and Free Roads*, Americans were able to get a first glance at the world of future highways at the General Motors “Highways and Horizons” exhibit at the 1939 World’s Fair in New York. This was the most popular and most expensive attraction at the Fair, and people waited two hours to take the 15-minute ride into designer Norman Bel Geddes’ vision of 1960. Over the course of the Fair, 2 million people visited the \$6 million installation demonstrating 10-lane “super” highways (Patton 1986:120).

Two years later in 1941, President Roosevelt appointed the seven-member National Interregional Highway Committee. MacDonald served as chair, Fairbank served as secretary, and the committee included federal and state highway administrators and engineers, city planners, and the incoming president of AASHO. After more than two years of work, the committee published their findings in January 1944 in a document titled *Interregional Highways*, which outlined a system of interregional highways based on economic and social needs. The committee focused on population centers, agricultural production, timber and mining interests, manufacturing locations, and military bases in choosing routes. Additionally, the planners stressed coordination of the highway system with other modes of transportation, and coordination in road construction among all levels of government. Fairbank’s written summary of the committee’s work “remains the most significant document in the history of highways in the United States” (FHWA 1977:274).

Congress followed the recommendations of *Interregional Highways* in passing the Federal-Aid Highway Act of 1944, which authorized the designation of the national system of interstate highways. The Act apportioned \$1.5 billion dollars over a three-year period to begin at the end of the war. The act also set up a ratio to divide federal funds among the primary highway system (45 percent), the secondary system (30 percent), and urban routes (25 percent), a division that remained in use for almost 30 years. Many of the provisions of the landmark 1944 Act came directly from the highway planning efforts advocated by Fairbank and MacDonald (FHWA 1977:276-277).

“NO BOUNDARIES”

By 1948, traffic volumes on the nation’s highways had rebounded to the pre-war 1941 level. In addition, many Americans resettled in new cities, sometimes to take new jobs and sometimes to take advantage of a different climate. Many moved to the West. After the war, more than 8 million people moved west across the Mississippi, and 3.5 million moved into California alone (Scott and Kelly 1988:148). As a former soldier remembered,

After the war, there was a traffic jam. One of the things every GI had fought for in World War II was to protect his rights as an American. And one of those rights was to be able to get in his car, turn the key, and go anywhere he wanted to. There are no boundaries here; the highways are not closed in the dark, or at state borders. As long as he had the money for a car, he could go anywhere he wanted (Scott and Kelly 1988:148).

In the late 1940s, four eastern states built high-speed, controlled access highways and charged tolls for their use. These modern highways in Pennsylvania, New Jersey, Massachusetts, and New Hampshire “set a high standard of excellence . . . and whetted the public appetite for better free roads” (FHWA 1977:168).

Post-war Congressional appropriations for highway construction followed the lead of the 1944 Federal-Aid Highway Act, and did not begin to appropriate money specifically earmarked for an interstate system of free roads until 1952. From 1946 through 1951, Congress voted \$500 million per year for road construction. The 1952 appropriation increased annual funding to \$550 million for two years, and the 1954 Federal-aid Highway Act raised the amount to \$875 million (FHWA 1977:166). The 1952 legislation was the first to earmark funds for the interstate system, setting aside \$25 million per year with a 50-50 federal-state matching ratio. The 1954 act jumped the interstate funds up to \$175 million per year for two years and changed the federal-state match ratio to 60-40.

The Federal-Aid Highway Act of 1956, signed by President Eisenhower, authorized significant funding for the construction of the 41,000-mile system by setting up a Highway Trust Fund from the collection of federal excise taxes and an increase in the gasoline tax. In contrast to the traditional two-year funding bill, the 1956 act provided long-term financing for the interstate highway system, authorizing \$27 billion, based on a federal-state 90-10 matching ratio (FHWA 1977:254-255). As of 1999, 42,795 miles had been designated for development with interstate construction funds and American taxpayers had spent \$129 billion to build this system (FHWA 2001). The system, now officially designated as the Dwight D. Eisenhower System of Interstate and Defense Highways, continues to expand. More than 3,600 additional miles have been added as Alaska, Hawaii, and Puerto Rico have been included and new corridors continue to be developed in the continental United States.

In reviewing his long tenure as chief administrator for American roads, Thomas MacDonald summed up the relationship between the post-war expansion of highways and the post-war expansion of the economy.

We were not a wealthy nation when we began improving our highways . . . but the roads themselves helped us create a new wealth, in business and industry and land values. . . . So it was not our wealth that made our highways possible. Rather it was our highways that made our wealth possible (FHWA 1977:257).

The federal-aid system of financing America’s highways began with the 1921 Federal Highway Act appropriating \$75 million and continued through the \$27 billion Federal-Aid Highway Act of 1956. The system has been a success because of consistent Congressional appropriations, strong state highway organizations, and the contributions of the Bureau of Public Roads. Beginning as a rural post road improvement program, the program has expanded to fund thousands of miles of American highway.

CHAPTER 3

THE TECHNOLOGY OF AMERICAN ROAD BUILDING, 1776-1956

Road construction technology has evolved substantially during the last century. From about 1900 until 1920, motorists drove on wagon roads, and between about 1920 and 1930, motorists traveled on wagon roads that had been adapted for the automobile, largely by the addition of surfacing to fight the problem of dust. It was not until the 1930s that the new science of road engineering created roads designed specifically for motor vehicle traffic, and the invention of new road machinery facilitated their construction. After about 1940, the science of road engineering turned to designing freeways. Our grandparents may have thought of a team of horses and a scraper as road building equipment. The phrase “road construction” now brings to mind the sights and sounds of noisy heavy equipment chuffing diesel smoke, orange warning flags snapping in the dusty breeze, and the acrid smell of hot, fresh asphalt.

TRADITIONAL ROAD BUILDING METHODS

To understand twentieth century road construction, it is helpful to take a quick look back at the most widely used ancient and historic road building methods. The four big names in pre-twentieth century road construction—Rome, Tresaguet, Telford, and MacAdam—each used stones to pave roads for wagons.

Two thousand years ago, Roman workers built the Appian Way by placing large blocks of lava in a foundation of cement that ranged from 13 to 17 feet wide. The Romans “crowned” their roads, that is, they built the center of the road higher than the edges in order to drain water off the roadways, a technique still used today. Europeans of the Middle Ages continued to use the Roman roads, and many remain in existence today (Theisen 1937:10-11).

The name of the Director General of French Roads, J.P.M. Tresaguet (1775-1785), has been attached to his improvements on the ancient Roman method of road building. Tresaguet pioneered what is now known as the “Tresaguet method,” which added several layers of stone broken into small pieces over a foundation of larger stones. Tresaguet also added ditches alongside the crowned roadway to drain water from the roads. His roads were about 18 feet wide, not including the side ditches. Perhaps the Frenchman’s most important contribution to road building was his insistence on constant maintenance of roads by well-trained and well-paid workers (FHWA 1977:12-13).

In the early 1800s, Englishman Thomas Telford filled cracks between large road foundation stones with dirt, and covered the foundation stones with smaller stones. He used fine gravel as a finishing layer on 18-foot-wide roads, and put drains across the road at 100-yard intervals. Between 1802 and 1820, Telford oversaw the construction of 920 miles of roads and 1,200 bridges in England (Theisen 1937:10-11).

Also in the first decades of the nineteenth century, J.L. MacAdam initiated the use of a single layer of small, broken granite pebbles to build roads without a foundation of large stone blocks. The Scotsman believed the foundation courses of large stones were inefficient and unnecessary because the soil alone supported the road, and he directed the building of roads using small stones packed into a dense mass and set with water. MacAdam published his guidelines in an 1816 pamphlet, *Remarks (Or Observations) on the Present System of Road Making*. Roads built with his technique are now termed “macadam roads.” MacAdam also laid the first road made of concrete in 1865 (Theisen 1937:10-11).

In nineteenth-century America, road construction often involved little more than removing large boulders, chopping vegetation, and leveling the worst irregularities of the ground surface to allow the passage of wagons in single file. The best roads of the time were

12 to 15 feet wide, a width that was adequate for two loaded wagons to pass each other with the horses at a walk. To shed water quickly, these roads were crowned on both the straight sections and the curves, and the crown, 6 to 8 inches higher in the center, was steep enough to make driving at the sides uncomfortable. Consequently all traffic ran in the middle, taking to the right hand side of the road only to pass other vehicles (FHWA 1977:381).

Simple roads through the countryside became mud in the spring thaws and after rains, a problem partially solved by various methods of surfacing dirt roads. Some of the state-chartered turnpikes of the early 1800s were simply graded and ditched, and some were surfaced with wooden planks, a technique introduced in this country from Canada in 1846. The best were surfaced with gravel or hand-pounded¹ stone in the Tresaguet or MacAdam methods. Road construction did not often include bridge construction, so travelers forded smaller streams in their wagons or were ferried across the larger rivers.

THE NEW SCIENCE OF ROAD CONSTRUCTION

The century-old wagon road techniques of Telford, MacAdam, and Tresaguet failed under the increased traffic, weight, and speeds of automobiles and trucks, and the new motor vehicles spurred the invention of new road construction technology. Just as Henry Ford and his cohorts invented variations on the automobile every year, Chief Thomas MacDonald and research crews at the Bureau of Public Roads, state highway departments, manufacturers, and several American universities invented the new science of road construction.

In the early twentieth century, the science both incorporated and rejected features of wagon roads and railroads, and added new practices. First, the new road engineers faced the challenge of improving the road surfaces. Second, they addressed safety and beautification issues. A third set of innovations of the new science focused on the development of modern road building machinery. Peripheral to road science but integral to road history is the development of roadside businesses to serve the traveling motorists.

Asphalt and Concrete

The first problem to be solved was dust. Wagons traveled along rural roads at less than 10 miles per hour. As faster and heavier motor vehicles took to the roads in greater numbers after the turn of the century, their wheels broke down the macadam surfaces and created clouds of dust marking their passage. In 1908, a Brown University professor enumerated for the American Society of Civil Engineers the myriad of attempts to control dust,

Among the methods used in the United States to alleviate the dust nuisance [are] sprinkling the surface with fresh water, salt water, a solution of calcium chloride, oils with a paraffin base, oils with an asphaltic base, oil of tar, oil emulsion, Westrumite, Dustoline, Asphaltoline, Tarracolio, and deliquescent salts (Rose 1976:84).

Almost from its inception and continuing to the present, the Office of Public Roads (now FHWA) has conducted research to test soils and paving mixtures, and has published their findings as guidelines for road construction. The most successful methods to combat dust have been asphalt and concrete paving. Urban road builders introduced asphalt paving in New York City and Philadelphia in 1871, and concrete in Bellefontaine, Ohio in 1891, but both asphalt and concrete were considered too costly to use on rural

¹The first machine to crush stone was not invented until 1858.

roads in the nineteenth century. The influx of federal money in the twentieth century overcame this objection (FHWA 1977:39, 67-68).

As in other parts of the country, initial efforts to surface roadways began in urban areas. In 1910 Phoenix, as in other Arizona towns, most road surfaces were simply graded dirt, but some had a layer of gravel and some had been oiled to combat dust. Nineteen blocks, chiefly on Washington Street and Central Avenue, were the first streets to be paved in January 1912, and in February, paving with a concrete base overlain with asphalt began on all streets between Fourth Street and Fourth Avenue. A year later, in March 1913, the city authorized the paving of all the remaining streets in the original Phoenix townsite, and by 1915, a total of 7 miles of Phoenix streets had been paved. Five years later, that number had increased more than threefold to 25 miles and all the streets in the original town site were paved. By 1929, the extent of paving more than tripled again and 86 miles had been paved (David 1976:11-13; Luckingham 1989:52-53). These efforts spread into the surrounding rural areas, and the local newspaper boasted in May 1924, "Through the Salt River Valley, radiating from Phoenix in all directions like spokes of a great wheel, are paved roads. No farmhouse is over two miles from a paved road" (Luckingham 1989:82). The newspaper failed to mention that these paved roads radiating from Phoenix represented most of the paved roads in the state at the time (see Pocket Map 2).

As early as 1904, the Office of Public Roads had surveyed American roads and found only 7 percent of the more than 2 million miles of rural highways surfaced in any way (Theisen 1937:11). It was not until 1909 that the first mile of rural public road was paved with concrete in Wayne County, Michigan, on the route from Detroit to the state fairgrounds (Rose 1976:95)². Four years later, a new 24-mile stretch of 9-foot-wide concrete road outside of Pine Bluff, Arkansas became a tourist attraction because the smoothness of the surface allowed cars "to reach up to 45 mph, if the driver gives it full throttle. And it is said that many motorists actually brought their cars by railroad on a flat car to Pine Bluff where they rode up and down this road for two or three days" (Ray 1984:4-5).

After the influx of federal money into road construction in the 1920s, 23 percent of the highways in the United States had been surfaced by 1930. However, most of the surfacing was macadam or gravel, and only 3 percent of the total mileage had been surfaced with concrete, asphalt, or brick (Scott and Kelly 1988:26).³ While the 1920s witnessed road construction and route consolidation, the 1930s brought both asphalt and concrete to America's roads. As a typical example, the route of U.S. Highway 66 had been determined by 1926, but the last 4-mile stretch did not receive asphalt paving until 1937 (Housley 1996:44, 68).

Safety

In solving the first problem of dust, road engineers inadvertently helped to create the second problem, traffic accidents. Dustless road surfaces allowed drivers to travel in greater numbers at greater speeds on roads designed for wagons, and the number of accidents grew at a rate alarming to an American public unused to such grisly statistics.⁴ By 1927, the number of lives lost on the roads equaled the number of American lives lost in World War I, and by 1934, the state of Arizona claimed the unhappy distinction of being second in the nation in highway deaths per capita (Housley 1996:77; Rodda 1992:16).

² The first concrete city street had been poured 16 years earlier in Ohio; the essentially unaltered segment is now listed in the National Register (Appendix E).

³ Although more rural roads were surfaced with concrete than asphalt between about 1920 and 1932, gravel, asphalt, and concrete all have been used to surface roads since 1920.

⁴ The inefficient brakes and weak lights of early automobiles also contributed to highway mortality.

In 1919, an engineer from the Bureau of Public Roads described the current state of road design.

During the past ten years, the transition from horse-drawn to motor traffic has been so nearly complete that horse-drawn traffic can no longer be considered a controlling factor in highway design; yet practically all of the basic principles of highway construction were evolved for horse-drawn traffic (FHWA 1977:120).

The basic principles of highway design in 1919 lacked safety elements such as guardrails, passing lanes, and shoulders. After about 1930, road engineers designed new safety features including increasing sight lines on curves and at intersections, adding shoulders, and widening the roads. Designing for safety also included eliminating certain road elements such as steep road grades, roadside signs and utility poles at the edges of the narrow roads, and hazardous railroad crossings. Later, road designers incorporated additional lanes and the concepts of limited access and divided roadways to lower the accident rate.

The innovative road commissioner of Wayne County, Michigan painted a white line down the center of road curves and bridges in 1911, and later added a white center line to all his county highways. In 1924, the National Conference on Street and Highway Safety recommended that “rural highways should be marked with a white center line on curves, at and near hill crests, at irregular intersections, and at any other point where safety requires that motorists keep strictly to the right” (FHWA 1977:406). The Arizona Highway Department adopted highway striping the same year. The conference further recommended that “objects near the roadway, such as curbs, poles, fences, and rock surfaces, should be painted white. Obstructions such as columns and curbs, at the centers of underpasses, should be striped diagonally black and white” (FHWA 1977:406).

The first standards of practice adopted by AASHO in 1928 recommended 10-foot-wide lanes, pavements at least 6 inches thick with a 1-inch crown in the middle, and 8-foot-wide shoulders when practicable. By 1940, AASHO recommended 16-foot to 24-foot widths for two-lane roads, and shoulders 8 to 10 feet wide free of all obstructions such as utility poles and signs (FHWA 1977:388, 393).

Between 1938 and 1944, AASHO cooperated with the Bureau of Public Roads to publish a series of seven important design policy brochures, “the fundamental structure upon which all subsequent geometric design policy for highways has been based” (FHWA 1977:390). The seven brochures dealt with: (1) highway classification by traffic volume, character of traffic, and speed; (2) required sight distances for hills, curves, and passing; (3) marking and signing no-passing zones; (4) highway types by number of lanes; (5) measurements for various types of intersections; (6) policies on rotary intersections; and (7) grade separations and ramps. These policies have been continually upgraded and re-published, and many remain in use today.

Machinery

Central to the history of road building is the history of road building machinery. Ironically, much of the building of early automobile roads was done with draft animals (Figure 7). Horses and mules, not machines, pulled road-grading equipment in the 1910s and into the 1920s (Scott and Kelly 1988:30). After World War I, the Army delivered more than \$200 million of surplus “trucks, some crawler tractors, compressors, and early-day power shovels,” as well as the explosive TNT to the Bureau of Public Roads and state highway departments (FHWA 1977:105-106; Gray 1995d:16). Despite the donation of surplus military machinery, many road builders in the early 1920s continued to use horses and mules, with the big switch from animal power to motorized machinery occurring in the late 1920s and into the 1930s (Bowden 1995). A similar migration of machinery took place in Arizona after the completion of Hoover

Dam. The dam contractor auctioned off much of the dam construction equipment, and the bulldozers and tractor-drawn scrapers began to be used for highway construction in the 1930s (Gray 1995d:17).



Figure 7. Mules in Arizona Road Construction, circa 1920

More and better machinery made earthwork (that is, the process of making “cuts” and “fills” to even out the roadbed) easier and cheaper. Wagon roads had grades of no more than about 4 to 6 percent, resulting “in rather crooked locations carefully selected to avoid steep grades, closely fitted to the terrain, with small cuts and fills to save grading costs” (FHWA 1977:382). The builder of a wagon road often had to sacrifice a straight alignment in favor of avoiding steep climbs and drops. With enough labor, cuts and fills could have been made through more rugged terrain, as demonstrated by contemporaneous railroad construction, but the expense was not justified. The new machinery made it economically feasible for road builders to construct straighter roads with gentler grades “of a type that had heretofore existed only in the fanciful minds of design engineers” (FHWA 1977:394).

In addition to straightening wagon roads, the new machinery improved the grades of early automobile roads. Encouraged by the greater power of automobiles to climb hills and daunted by the expense of animal-powered earthwork, early builders constructed automobile roads with grades of up to 9 percent. The surplus World War I compressors (for drilling machines) and the TNT donated by the Army facilitated cuts, and by the 1930s, bulldozers and other new road grading equipment facilitated the hauling of dirt from road cuts to fills, making earthwork less costly (Gray 1995d:17). In addition, the increased public awareness of safety issues contributed to lowering road grades back down to about 6 percent.

Highway engineers of the 1920s and 1930s agreed with the Delaware State Highway Engineer who reminded them that the straight line is the shortest distance between two points and “ideally aligned commercial roads are those that are laid in absolutely straight lines” (FHWA 1977:126). This philosophy, which owed much to the railroad tradition of long, straight tangents, gentle curves, and easy grades, left “a legacy of thousands of miles of absolutely straight monotonous highway” (FHWA 1977:126).

More and better machinery also led to increased use of concrete and asphalt. Invention of a bituminous distributor in 1919 facilitated the application of asphalt, and invention of the traveling concrete mixer in 1923 replaced the time-consuming wheelbarrow delivery of wet concrete to the road site. Other important

inventions included the addition of powerful diesel engines to tractors and graders in 1931, and the addition of large pneumatic tires to dump trucks and scrapers by 1934 (FHWA 1977:453-454).

Comfort

Early motorists found no roadside accommodations for oil or gasoline, tire repair, engine parts, meals, overnight stays, or even public rest rooms, and an automobile trek often resembled a safari.

Poor roads and the absence of roadside services outside of population centers made early auto travel a grand adventure for those with fortitude. Most automobilists reveled in overcoming wretched road conditions and welcomed the isolation of camping along a picturesque roadside at the end of a dusty, jarring ride. Drivers loaded their vehicles with supplies of all kinds, including food, camping gear, tires, and extra gasoline (Rodda 1992:6).

The proliferation of roadside accommodations followed the pattern of federal road dollars—very few before 1920, a significant number in the 1920s, and a large increase during the 1930s. Tourist camps began as free campgrounds on the fringes of cities, but these first simple overnight rest stops were banned in the 1930s for health reasons. The only traces of them today may be stands of shade trees. The first tourist camp in the United States to offer accommodations in cabins was opened in Douglas, Arizona in 1913, on U.S. Highway 80 (Rodda 1992:13).

To aid both tourists and residents, the state of Arizona began publishing road maps on an annual basis in 1926.⁵ At first, the maps were simple one- or two-color printing jobs, on only one side of the page. By 1932, the State Highway Department used the reverse of the map to promote tourist attractions with a montage of 21 black-and-white photographs titled “Scenes Portraying a Few of the Interesting Features within Arizona.” Perhaps due to the self-interest of the department publishing the map, fully one-third of the photographs are illustrations of roads. Mingled with photographs of such attractions as the Arizona desert, Grand Canyon, State Capitol, prehistoric cliff dwellings, and Mission San Xavier del Bac are photographs depicting a “Paved Highway Crossing Queen Creek,” and the “Concrete Pavement Near Buckeye.” Photographs of the curves of the Apache Trail rounding Fish Creek Hill, the single-lane road up the San Francisco Peaks, and a view looking out from the Claypool Tunnel demonstrate the continuing existence of dirt roads. The summary of traffic laws on the maps states that the speed limit for passenger cars on “open country highway” is 35 miles per hour (Arizona State Highway Department 1932).

A sufficient number of tourist camps had appeared by the side of Arizona roads in 1925 that the Arizona State Board of Health started a tourist camp inspection program to check on sanitary conditions and published their findings in a AAA brochure for travelers (Housley 1996:51-52). By 1939, the more than 2 million visitors each year had made tourism the state’s largest and fastest growing industry worth \$70 million a year (Rodda 1992:20). In 1940, researchers claimed the federal highways across Arizona (U.S. Highways 60, 66, 70, and 80) carried one half of the nation’s east-west transcontinental traffic (Arizona State Highway Commission and others 1941). Businesses catering to the road population included tourist camps, tourist courts (or motor hotels), filling stations, and diners. These “Arizona Roadside Property Types” have been previously described in the historical context, *Automotive Transportation in Arizona 1900-1940* (Rodda 1992).

⁵The Arizona Government Documents section of the Hayden Library, Arizona State University includes a full set of the Arizona State Highway Department road maps from 1926 to 1974, as well as a set of Drivers License Manuals from the 1950s to 1974. In 1974, the Arizona State Highway Department merged with the Arizona Department of Aeronautics to form the new ADOT.